

FORM PTO-1390	U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371	ATTORNEY'S DOCKET NUMBER: PF-2568 U.S. APPL. NO. (If known, see 37 CFR 1.5) <b>09/913937</b>
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INTERNATIONAL APPLICATION NO.:  
PCT/JP00/00949

INTERNATIONAL FILING DATE:  
18 FEBRUARY 2000

PRIORITY DATE CLAIMED:  
19 FEBRUARY 1999

TITLE OF INVENTION: METHOD FOR EXTRACTING FEATURE OF BINARY IMAGE

APPLICANT(S) FOR DO/EO/US: Chiaki TODAKA

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. ☒ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
  - a. ☒ is transmitted herewith (required only if not transmitted by the International Bureau).
  - b. ☐ has been transmitted by the International Bureau. (see attached copy of PCT/IB/308)
  - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. ☐ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3)).
  - a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
  - b. ☐ have been transmitted by the International Bureau.
  - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
  - d. ☐ have not been made and will not be made.
8. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. ☐ A translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Item 11. to 16. below concern document(s) or information included:

11. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☒ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☒ A **FIRST** preliminary amendment.
- ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
14. ☐ A substitute specification.
15. ☐ A change of power of attorney and/or address letter.
16. ☒ Other items or information:

INTERNATIONAL PRELIMINARY EXAMINATION REPORT (PCT/IPEA/409), INTERNATIONAL SEARCH REPORT (PCT/ISA/210), ABSTRACT on a separate sheet, APPLICATION DATA SHEET

U.S. APPLICATION NO. (if known, 37 CFR 1.7)

09/913937

INTERNATIONAL APPLICATION NO.  
PCT/JP00/00949ATTORNEY'S DOCKET NO.  
PF-256817. ☒ The following fees are submitted:**BASIC NATIONAL FEE (37 CFR 1.492(a)(1)-(5)):**

Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO ..... \$ 1,000.00

International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO ..... \$ 860.00

International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO ..... \$ 710.00

International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) ..... \$ 690.00

International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) ..... \$ 100.00

**ENTER APPROPRIATE BASIC FEE AMOUNT =**

\$ 860.00

Surcharge of \$130.00 for furnishing the oath or declaration later than months from the earliest claimed priority date (37 CFR 1.492(e)).

\$

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE	\$
Total claims	8 - 20 =	0	X \$18.00	\$
Independent claims	1 - 3 =	0	X \$80.00	\$

Multiple dependent claims (if applicable) ..... + \$270.00

\$

**TOTAL OF ABOVE CALCULATIONS =**

\$ 860.00

Reduction of 1/2, if applicant is entitled to Small Entity status under 37 CFR 1.27. +

\$

**SUBTOTAL =**

\$ 860.00

Processing fee of \$130 for furnishing the English translation later than months from the earliest claimed priority date (37 CFR 1.49(f)).

\$

**TOTAL NATIONAL FEE =**

\$ 860.00

Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). \$40.00 per property +

\$

**TOTAL FEES ENCLOSED =**

\$ 900.00

Amount to be  
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a. ☒ A check in the amount of \$ 900.00 to cover the above fees is enclosed.b. ☐ Please charge my Deposit Account No. **25-0120** in the amount of \$ to cover the above fees. A duplicate copy of this sheet is enclosed.c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required by 37 CFR 1.16 and 1.17, or credit any overpayment to Deposit Account No. **25-0120**. A duplicate copy of this sheet is enclosed.

SEND ALL CORRESPONDENCE TO:

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August 20, 2001

By

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09/913937  
JC05 Rec'd PCT/PTO 2 0 AUG 2001

PATENTS

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of

Chiaki TODAKA

Box PCT

Serial No. (unknown)  
(PCT/JP00/00949)

Application Branch

Filed herewith

METHOD FOR EXTRACTING  
FEATURE OF BINARY IMAGE

PRELIMINARY AMENDMENT

Commissioner for Patents

Washington, D.C. 20231

Sir:

Prior to the first Official Action and calculation of the filing fee, please amend the above-identified application as follows:

IN THE CLAIMS:

Amend claim 3 as follows:

--3. (Amended) A method for extracting feature quantities of a binary image according to claim 1, further comprising a step of performing scanning one line of the image data to provide N pixels (N being an integer greater than or equal to 1) that follows an image area having a prescribed area number that has just terminated as semi-image areas of an adjacent image area.--

Amend claim 4 as follows:

--4. (Amended) A method for extracting feature quantities of a binary image according to claim 1, further comprising a step of performing scanning one line of the image data to provide N pixels (N being an integer greater than or equal to 1) that follows an image area having the same area number that has just terminated as semi-image areas of an image area that is adjacent from right above when the image area having a prescribed area number terminated at the pixel that is located right above on immediately preceding line.--

Amend claim 5 as follows:

--5. (Amended) A method for extracting feature quantities of a binary image according claim 3, further comprising a step of scanning the line buffer in a reverse direction and modifying the different area numbers to the common area number when consecutive pixels belong to respective image areas and semi-image areas but have different area numbers after the scanning of the one line has completed.--

Add the following new claims:

--6. (New) A method for extracting feature quantities of a binary image according to claim 2, further comprising a step of performing scanning one line of the image data to provide N pixels (N being an integer greater

than or equal to 1) that follows an image area having a prescribed area number that has just terminated as semi-image areas of an adjacent image area.

--7. (New) A method for extracting feature quantities of a binary image according to claim 2, further comprising a step of performing scanning one line of the image data to provide N pixels (N being an integer greater than or equal to 1) that follows an image area having the same area number that has just terminated as semi-image areas of an image area that is adjacent from right above when the image area having a prescribed area number terminated at the pixel that is located right above on immediately preceding line.

--8. (New) A method for extracting feature quantities of a binary image according claim 4, further comprising a step of scanning the line buffer in a reverse direction and modifying the different area numbers to the common area number when consecutive pixels belong to respective image areas and semi-image areas but have different area numbers after the scanning of the one line has completed.--

R E M A R K S


The above changes in the claims merely place this national stage application in the same condition as it was

during Chapter II of the international stage, with the multiple dependencies being removed.

Attached hereto is a marked-up version of the changes made to the claims by the current amendment. The attached page is captioned "VERSION WITH MARKINGS TO SHOW CHANGES MADE."

Respectfully submitted,

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August 20, 2001

VERSION WITH MARKINGS TO SHOW CHANGES MADE

Amend claim 3 as follows:

--3. (Amended) A method for extracting feature quantities of a binary image according to ~~any one of claims~~ ~~claim 1 and 2~~, further comprising a step of performing scanning one line of the image data to provide N pixels (N being an integer greater than or equal to 1) that follows an image area having a prescribed area number that has just terminated as semi-image areas of an adjacent image area.--

Amend claim 4 as follows:

--4. (Amended) A method for extracting feature quantities of a binary image according to ~~any one of claims~~ ~~claim 1 and 2~~, further comprising a step of performing scanning one line of the image data to provide N pixels (N being an integer greater than or equal to 1) that follows an image area having the same area number that has just terminated as semi-image areas of an image area that is adjacent from right above when the image area having a prescribed area number terminated at the pixel that is located right above on immediately preceding line.--

Amend claim 5 as follows:

--5. (Amended) A method for extracting feature quantities of a binary image according ~~any one of claims~~ ~~claim 3 and 4~~, further comprising a step of scanning the

line buffer in a reverse direction and modifying the different area numbers to the common area number when consecutive pixels belong to respective image areas and semi-image areas but have different area numbers after the scanning of the one line has completed.--



S/PRTS

09/913937  
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## METHOD FOR EXTRACTING FEATURE OF BINARY IMAGE

### TECHNICAL FIELD

The present invention relates to a method for extracting feature quantities of image data that is used in an image processing apparatus etc. In particular, the invention relates to a binary image feature quantity extracting method capable of extracting, properly and smoothly, an area, a circumferential length, end point coordinates, coordinates of the center of gravity, a second moment, etc. of each image area by scanning binary image data once.

### BACKGROUND ART

Conventionally, various methods were proposed for a means for extracting desired feature quantities from binary image data obtained by binarizing an image signal received from an imaging device such as a CCD camera.

For example, a method is known in which feature quantities such as an area, the center of gravity, and a principle axis angle are extracted in real time by preprocessing (binarizing) an image signal in the same time series as of a video signal, scanning the pixels of resulting binary data by a raster scanning method or the like, detecting an image from a "1" and "0" arrangement of the pixels, and performing various calculations such as

surface integral on the pixels belonging to a region of the image.

However, in this extracting method, surface integral is performed by extracting (accessing) all pixels to extract feature quantities such as an area and hence this method includes a number of processing steps. As such, this method is not suitable for high-speed processing.

In view of the above, conventionally, a binary image feature quantity extracting apparatus was proposed having a binary image storing means for storing a binary image; an outline tracing means for obtaining, as a closed loop, position coordinates of outline pixels by tracing the outline of the binary image that is stored in the binary image storing means; and a feature quantity calculating means for extracting feature quantities relating to a figure that is enclosed by the closed loop by integrating, along the closed loop representing the outline, a monomial relating to the position coordinates of the outline pixels obtained by the outline tracing means. The outline tracing means extracts an outline of an object or the like that exists in image data and traces the outline. The feature quantity calculating means calculates a 0th moment, a first moment, etc. based on position coordinate data of the pixels that constitute the outline, and calculates an area based on the 0th moment and calculates the center of gravity of the image based on the 0th moment and the first moment. In this manner, feature quantities such as an area and the center of gravity are detected

based on a small number of pixels, that is, pixel data that constitute an outline, while outline tracing (image detection) is performed.

The above conventional binary image quantity extracting apparatus extracts an outline of an image that exists in image data and traces the outline, and performs calculations such as calculating several kinds of moments based on position coordinate data of the pixels that constitute the outline, calculating an area based on a 0th moment, and calculating the center of gravity of the image based on the 0th moment and the first moment. Although the data processing amount can be reduced, the calculation processing is still complex and there are certain limits in the facilitation and the speed increase of the data processing for extracting feature quantities.

In general, the following feature quantities of image data are known.

#### 1. Area S

This feature quantity can be represented by the total number of pixels of a subject image area. With this feature quantity, very small noise can be eliminated easily because it has small values. Fig. 8 shows the areas S1 and S2 of image areas A1 and A2, respectively.

#### 2. Circumferential length L

This feature quantity can be represented by the number of end pixels of a subject image area (four-side adjacency). Rather

than used independently, its value is effective when used as a ratio to the area, that is, a feature quantity representing the degree of roundness. Fig. 8 shows the circumferential lengths  $L1$  and  $L2$  of the image areas  $A1$  and  $A2$ , respectively.

### 3. End point coordinates (top end, bottom end, right end, left end)

These feature quantities represent the coordinates of the top end, bottom end, right end, and left end of a subject image area. Their values provide position information of the subject image area and are useful for accessing the image data directly. Fig. 9 shows top coordinates  $(X1u, Y1u)$ , left end coordinates  $(X1l, Y1l)$ , bottom coordinates  $(X1d, Y1d)$ , and right end coordinates  $(X1r, Y1r)$  of the image area  $A1$  and top coordinates  $(X2u, Y2u)$ , left end coordinates  $(X2l, Y2l)$ , bottom coordinates  $(X2d, Y2d)$ , and right end coordinates  $(X2r, Y2r)$  of the image area  $A2$ .

### 4. Center of gravity coordinates

This feature quantity can be represented by center of gravity coordinates of a subject image area. These coordinate values are not necessarily located inside the subject image area. Their values can be calculated according to the following equation and serve to calculate the distance between image areas, for example.

$$X_G = \frac{1}{N} \sum_{j=1}^N x_j$$

$$Y_G = \frac{1}{N} \sum_{j=1}^N y_j$$

Fig. 10 shows center of gravity coordinates ( $X_{1g}$ ,  $Y_{1g}$ ) of the image area  $A_1$  and center of gravity coordinates ( $X_{2g}$ ,  $Y_{2g}$ ) of the image area  $A_2$ .

#### 5. Second moment

This feature quantity can be represented by the major axis length  $a$ , minor axis length  $b$ , and angle  $\theta$  of an ellipse having the same moment with calculation of a second moment of a subject image area. The values of these parameters can be calculated according to the following formulae:

$$a = \sqrt[4]{\frac{4}{\pi} M_{\min} \sqrt{\frac{M_{\min}}{M_{\max}}}}$$

$$b = \sqrt{\frac{M_{\max}}{M_{\min}}} a$$

where

$$M_{\max} = \text{Max}[S_{xx} \cos^2 \theta_n + S_{xy} \sin 2\theta_n + S_{yy} \sin^2 \theta_n]; n=0,1,2,3$$

$$M_{\min} = \text{Mim}[S_{xx} \cos^2 \theta_n + S_{xy} \sin 2\theta_n + S_{yy} \sin^2 \theta_n]; n=0,1,2,3$$

$$\theta_n = \frac{1}{2}(n\pi - \tan^{-1} \frac{2S_{xy}}{S_{yy} - S_{xx}})$$

where

$$S_{xx} = \sum_{i=1}^N x_i^2$$

$$S_{yy} = \sum_{i=1}^N y_i^2$$

$$S_{xy} = \sum_{i=1}^N x_i y_i$$

Fig. 11 shows a second moment ( $a_1, b_1, \theta_1$ ) of the image area A1 and a second moment ( $a_2, b_2, \theta_2$ ) of the image area A2.

After intensive studies and investigations, the inventor has found that an area, a circumferential length, end point coordinates, center of gravity coordinates, a second moment, etc. can be extracted properly and smoothly for each image area by the following method. That is, in extracting feature quantities such as an area, a circumferential length, end points, the center of gravity, and a moment of an image area by scanning, by a raster scanning method or the like, image data that is a binary to be displayed in one frame, setting is so made that when a pixel having a prescribed density is detected in scanning one line of the image data, the content of each of a pixel immediately preceding the detected pixel on the same line and a pixel that is on an

immediately preceding line and right above the detected pixel is checked, and that an area number of the one image area is inherited when the detected pixel belongs to the same image area as one of the above pixels. The above processing is performed sequentially on the succeeding pixels to store resulting image data in a line buffer, whereby the scanning of the one line is finished. At this time, when consecutive pixels belong to respective image areas but have different area numbers after the scanning of the one line has completed, the line buffer in the reverse direction is scanned to modified the different area numbers to the same area number. Setting is so made that line scanning is performed over the entire one frame, that is, to its last line, in the same manner as performed above, whereby feature quantities are stored for each image area.

Therefore, an object of the invention is to a binary image feature quantity extracting method capable of extracting, properly and easily, necessary feature quantities of each image area by scanning binary image data once.

#### DISCLOSURE OF THE INVENTION

To attain the above object, the present invention provides A method for extracting feature quantities of a binary image for extracting feature quantities such as an area, a circumferential length, end points, a center of gravity, and a moment of an image area by scanning, by a raster scanning method or the like, image

data that is a binary image to be displayed in one frame, characterized by comprising the steps of checking a content of each of a pixel immediately preceding the detected pixel on the same line and a pixel that is on an immediately preceding line and right above the detected pixel when a pixel having a prescribed density is detected in scanning one line of image data, inheriting an area number of the one image area when the detected pixel belongs to the same image area as one of the above pixels, performing the above processing sequentially on succeeding pixels to store resulting image data in a line buffer, scanning the line buffer in a reverse direction and modifying the different area numbers to the same area number when consecutive pixels belong to respective image areas but have different area numbers after the scanning of the one line has completed, and repeating the same line scanning to a last line of one frame to store feature quantities for each image area.

The above method may further comprise the steps of checking a content of each of a pixel immediately preceding the detected pixel on the same line and a pixel that is on an immediately preceding line and right above the detected pixel when a pixel having a prescribed density is detected in scanning one line of the image data, and inheriting an area number of the image area of the pixel right above the detected pixel with priority given to it when the detected pixel belongs to image areas of both of the above pixels.



The binary image feature quantity extracting method according to the invention, may further comprise a step of performing scanning one line of the image data to provide N pixels (N being an integer greater than or equal to 1) that follows an image area having a prescribed area number that has just terminated as semi-image areas of an adjacent image area.

The above method may further comprise a step of performing scanning one line of the image data to provide N pixels (N being an integer greater than or equal to 1) that follows an image area having the same area number that has just terminated as semi-image areas of an image area that is adjacent from right above when the image area having a prescribed area number terminated at the pixel that is located right above on an immediately preceding line.

The above method may further comprise a step of scanning the line buffer in a reverse direction and modifying the different area numbers to the common area number when consecutive pixels belong to respective image areas and semi-image areas but have different area numbers after the scanning of the one line has completed.

#### BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is an explanatory diagram showing a data structure of feature quantities of image data on which a binary image feature quantity extracting method according to the present

invention is practiced, that is, a memory format to be used for storing feature quantities of image data;

Fig. 2 is an image data explanatory diagram showing how an image area of image data is generated in the binary image feature quantity extracting method according to the invention;

Figs. 3(a)-3(c) are image data explanatory diagrams showing different ways an image area of image data is inherited in the binary image feature quantity extracting method according to the invention;

Figs. 4(a) and 4(b) are image data explanatory diagrams showing how image areas of image data are combined with each other in the binary image feature quantity extracting method according to the invention;

Fig. 5 is an image data explanatory diagram showing how a connection image area of image data is generated in the binary image feature quantity extracting method according to the invention;

Fig. 6 is an image data explanatory diagram showing how a connected image area of image data is inherited in the binary image feature quantity extracting method according to the invention;

Figs. 7(a) and 7(b) are image data explanatory diagrams showing how connected image areas of image data are combined with each other in the binary image feature quantity extracting method according to the invention;

Fig. 8 is an image data explanatory diagram showing areas and circumferential lengths of respective subject image areas of image data in a binary image feature quantity extracting method;

Fig. 9 is an image data explanatory diagram showing end point coordinates of subject image areas of image data in a binary image feature quantity extracting method;

Fig. 10 is an image data explanatory diagram showing center of gravity coordinates of subject image areas of image data in a binary image feature quantity extracting method; and

Fig. 11 is an image data explanatory diagram showing second moments of respective subject image areas of image data in a binary image feature quantity extracting method.

#### BEST EMBODIMENT FOR CARRYING OUT THE INVENTION

Next, the best embodiment for carrying out a binary image feature quantity extracting method according to the present invention will be described in detail with reference to the accompanying drawings.

Fig. 1 shows a binary image feature quantity extracting method according to an embodiment of the invention. Specifically, Fig. 1 shows a data structure for each image area for which feature quantities should be extracted, that is, a memory format to be used for storing feature quantities of image data. In this embodiment, the feature quantities of a binary

image are an area, a circumferential length, end point coordinates, center of gravity coordinates, and a second moment of each image area  $A_n$ .

Therefore, for an image area  $A_n$  shown in Fig. 1, with an image area effectiveness flag as the head, feature quantities of image data are arranged in order of an area, a circumferential length, a top point x coordinate, a top point y coordinate, a bottom point x coordinate, a bottom point y coordinate, a left end point x coordinate, a left end point y coordinate, a right end point x coordinate, a right end point y coordinate, the sum of x's, the sum of y's, the sum of  $x \cdot x$ 's, the sum of  $y \cdot y$ 's, and the sum of  $x \cdot y$ 's.

Next, a method of extracting feature quantities of a binary image will be described.

#### 1. Data processing relating to feature quantities

When image data of one picture is line-scanned, if a black pixel (any one of an effective image area) exists at coordinates  $(X_j, Y_j)$ , for example, the following writing processing is performed on a memory (line buffer) and data are stored there for feature quantities of the image data:

(1) Increment the area of the image area to which the pixel belongs.

(2) Increment the circumferential length if the pixel belongs to the boundary of the image area.

(3) Perform replacement if the pixel is located at an end

of the image area (end point coordinates).

(4) Update the sum of  $x'$ 's (used for calculation of center of gravity coordinates).

(5) Update the sum of  $y'$ 's (used for calculation of center of gravity coordinates).

(6) Update the sum of  $x \cdot x'$ 's (used for calculation of a second moment).

(7) Update the sum of  $y \cdot y'$ 's (used for calculation of a second moment).

(8) Update the sum of  $x \cdot y'$ 's (used for calculation of a second moment).

## 2. Generation of feature quantities

In a scan of one line of image data, if a black pixel  $A_n$  is detected as mentioned above, as shown in Fig. 2 what image area the subject pixel  $A_n$  belongs to is determined by checking a pixel  $A_{n-1}$  that immediately precedes the pixel  $A_n$  on the same line and a pixel  $A_{n+1}$  that is located on the immediately preceding line and right above the pixel  $A_n$ . If neither pixel has an image area, a new image area  $A_1$  is generated.

## 3. Inheritance of feature quantities

In a scan of one line of image data, as shown in Figs. 3(a)-3(c), the pixel  $A_{n-1}$  immediately preceding the subject pixel  $A_n$  and/or the pixel  $A_{n+1}$  right above the subject pixel  $A_n$  is checked and what image area each pixel belongs to is determined. If the pixel  $A_{n-1}$  immediately preceding the subject pixel  $A_n$  has

an image area A2, the subject pixel An inherits the image area A2 at its side (see Fig. 3(a)).

If the pixel An+1 right above the subject pixel An has an image area A2, the subject pixel An inherits the image area A2 located right above (see Fig. 3(b)).

If the pixel An-1 immediately preceding the subject pixel An and the pixel An+1 right above the subject pixel An have image areas A1 and A2, respectively, the subject pixel An inherits the image area A2 of the pixel An+1 right above the subject pixel An with priority given to it (upwardness priority; see Fig. 3(c)).

#### 4. Combining of feature quantities

When a scan of one line of image data has finished after repetition of the above-described generation and inheritance of feature quantities, there may be a case that consecutive image areas have different area numbers as shown in Fig. 4(a). In this case, to combine the image areas, the line buffer is scanned in the reverse direction. Then, as shown in Fig. 4(b), all the pixels adjacent to each other are caused to belong to the same image area A2 and the image areas to be used for the data processing for feature quantities are combined with each other. Portions that have been emptied of data are initialized and are subjected to used in the next data processing.

By performing the generation, inheritance, and combining of feature quantities for each one-line scan of the image data in the above-described manner to the last line, individual

feature quantities can be stored in the memory (line buffer) according to the data structure (memory format) shown in Fig. 1 on an image area basis.

#### 5. Connection of feature quantities

It is effective to regard, as belonging to the same image area, image areas that have been obtained as a result of the above processing of generation, inheritance, and combining of feature quantities and that do not satisfy the conditions of combining and distant from each other by several pixels. That is, this is necessary for image data of "dot marking," "blurring," or the like.

Specifically, two image areas that are distance from each other by  $N$  pixels, say, two pixels ( $N = 2$ ), are connected to each other to form the same area with the two adjacent pixels regarded as belong to respective semi-image areas. This connection technique is used in the same manner as the above processing of generation, inheritance, and combining of feature quantities.

##### (a) Generation of connected image area

As shown in Fig. 5, after generation of an image area  $A2.0$  at a subject pixel  $A_n$ , semi-image areas  $A2.1$  and  $A2.2$  ( $N = 2$ ) are generated at the two following pixels  $A_{n+1}$  and  $A_{n+2}$  and distance information is stored in the line buffer together with the information of the image area  $A2.0$ .

##### (b) Inheritance of connected image area

Similarly, if the pixel  $A_{n+1}$  right above a subject pixel

An has an image area A2.0, inheritance is made with semi-image areas A2.1 and A2.2 generated at two pixels adjacent to each other, that is, the subject pixel An and the immediately following pixel  $An_{+1}$ , respectively.

(c) Combining of connected image areas

If consecutive image areas have different area numbers as shown in Fig. 7(a), the line buffer is scanned in the reverse direction and adjacent pixels are caused to belong to the same area (or its semi-image areas) as shown in Fig. 7(b).

Therefore, the above-described binary image feature quantity extracting method according to the invention makes it possible to extract, properly and smoothly, feature quantities that are an area, a circumferential length, endpoint coordinates, center of gravity coordinates, and a second moment of each image area based on data relating to feature quantities that have been extracted for the image area.

Although the best embodiment for carrying out the embodiment has been described above, the invention is not limited to the above embodiment and various design modifications are possible without departing from the spirit and scope of the invention.

INDUSTRIAL APPLICABILITY

The invention provides a method for extracting feature quantities of a binary image for extracting feature quantities



such as an area, a circumferential length, end points, a center of gravity, and a moment of an image area by scanning, by a raster scanning method or the like, image data that is a binary image to be displayed in one frame, characterized by comprising the steps of checking a content of each of a pixel immediately preceding the detected pixel on the same line and a pixel that is on an immediately preceding line and right above the detected pixel when a pixel having a prescribed density is detected in scanning one line of image data, inheriting an area number of the one image area when the detected pixel belongs to the same image area as one of the above pixels, performing the above processing sequentially on succeeding pixels to store resulting image data in a line buffer, scanning the line buffer in a reverse direction and modifying the different area numbers to the same area number when consecutive pixels belong to respective image areas but have different area numbers after the scanning of the one line has completed, and repeating the same line scanning to a last line of one frame to store feature quantities for each image area. In this manner, an area, a circumferential length, end point coordinates, center of gravity coordinates, a second moment, etc. can be extracted properly and smoothly for each image area by scanning binary image data once.

## CLAIMS

1. A method for extracting feature quantities of a binary image for extracting feature quantities such as an area, a circumferential length, end points, a center of gravity, and a moment of an image area by scanning, by a raster scanning method or the like, image data that is a binary image to be displayed in one frame, characterized by comprising the steps of:

checking a content of each of a pixel immediately preceding the detected pixel on the same line and a pixel that is on an immediately preceding line and right above the detected pixel when a pixel having a prescribed density is detected in scanning one line of image data;

inheriting an area number of the one image area when the detected pixel belongs to the same image area as one of the above pixels;

performing the above processing sequentially on succeeding pixels to store resulting image data in a line buffer;

scanning the line buffer in a reverse direction and modifying the different area numbers to the same area number when consecutive pixels belong to respective image areas but have different area numbers after the scanning of the one line has completed; and

repeating the same line scanning to a last line of one frame to store feature quantities for each image area.

2. A method for extracting feature quantities of a binary

image according to claim 1, comprising the steps of:

checking a content of each of a pixel immediately preceding the detected pixel on the same line and a pixel that is on an immediately preceding line and right above the detected pixel when a pixel having a prescribed density is detected in scanning one line of the image data; and

inheriting an area number of the image area of the pixel right above the detected pixel with priority given to it when the detected pixel belongs to image areas of both of the above pixels.

3. A method for extracting feature quantities of a binary image according to any one of claims 1 and 2, further comprising a step of performing scanning one line of the image data to provide N pixels (N being an integer greater than or equal to 1) that follows an image area having a prescribed area number that has just terminated as semi-image areas of an adjacent image area.

4. A method for extracting feature quantities of a binary image according to any one of claims 1 and 2, further comprising a step of performing scanning one line of the image data to provide N pixels (N being an integer greater than or equal to 1) that follows an image area having the same area number that has just terminated as semi-image areas of an image area that is adjacent from right above when the image area having a prescribed area number terminated at the pixel that is located right above on an immediately preceding line.

5. A method for extracting feature quantities of a binary image according to any one of claims 3 and 4, further comprising a step of scanning the line buffer in a reverse direction and modifying the different area numbers to the common area number when consecutive pixels belong to respective image areas and semi-image areas but have different area numbers after the scanning of the one line has completed.

## ABSTRACT OF THE DISCLOSURE

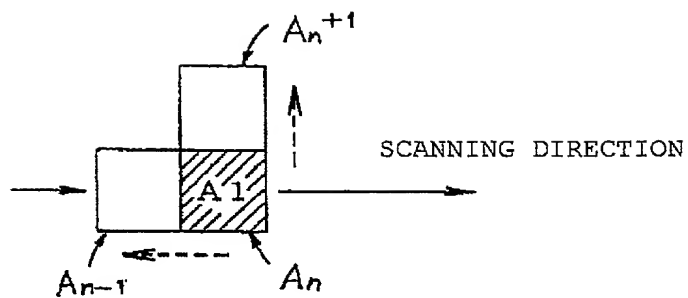
Feature quantities such as an area, a circumfer-  
ential length, end points, the center of gravity, and a moment  
are extracted for each image area. When one of the pixel  
immediately preceding the detected pixel on the same line and  
the pixel that is on the immediately preceding line and right  
above the detected pixel belongs to a prescribed image area  
after a pixel having a prescribed density is detected in  
scanning one line, the area number of the image area is  
inherited. The processing is performed sequentially on the  
succeeding pixels to store resulting image data are stored in  
a line buffer.

[FIG. 1]

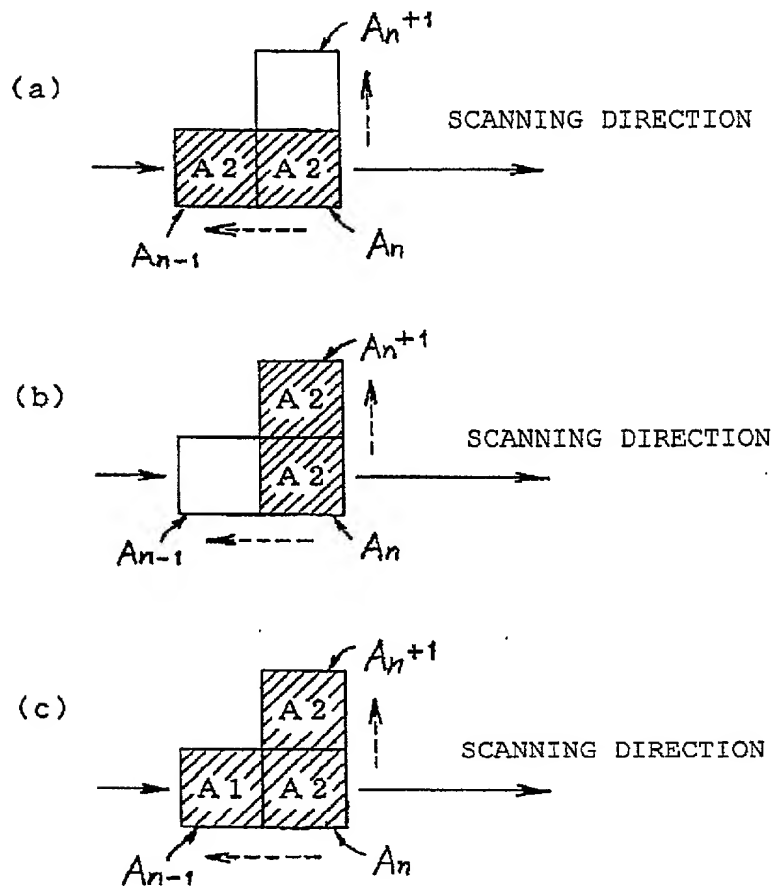
An

IMAGE AREA EFFECTIVENESS FLAG
AREA
CIRCUMFERENTIAL LENGTH
TOP POINT $x$ COORDINATE
TOP POINT $y$ COORDINATE
BOTTOM POINT $x$ COORDINATE
BOTTOM POINT $y$ COORDINATE
LEFT END POINT $x$ COORDINATE
LEFT END POINT $y$ COORDINATE
RIGHT END POINT $x$ COORDINATE
RIGHT END POINT $y$ COORDINATE
SUM OF $x'$ 'S
SUM OF $y'$ 'S
SUM OF $x \cdot x'$ 'S
SUM OF $y \cdot y'$ 'S
SUM OF $x \cdot y'$ 'S

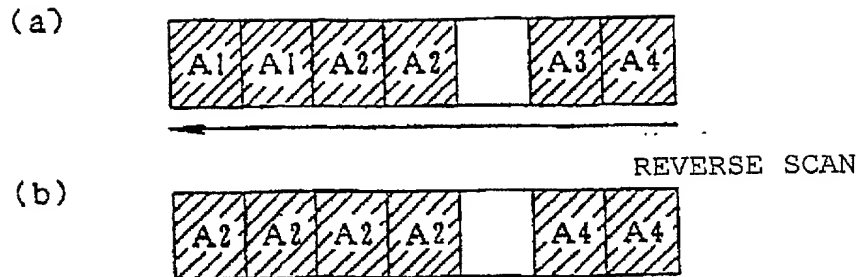
[FIG. 2]



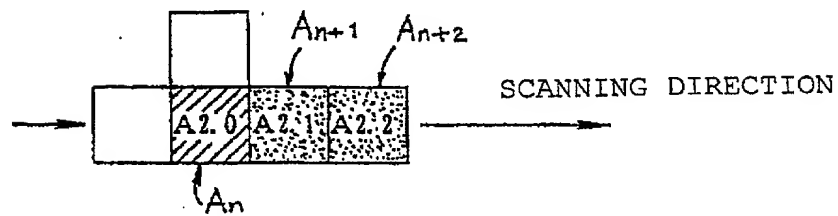
[FIG. 3]



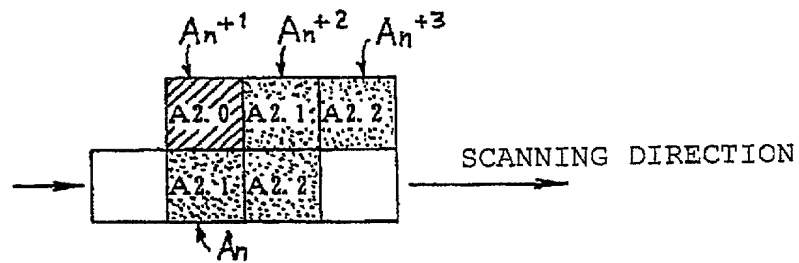
[FIG. 4]



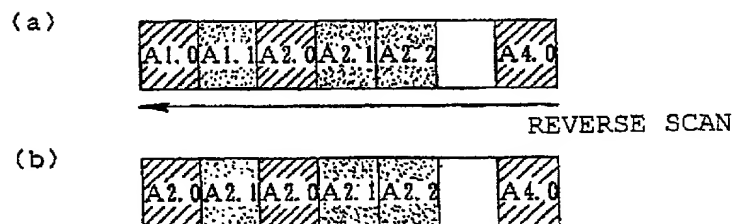
[FIG. 5]



[FIG. 6]

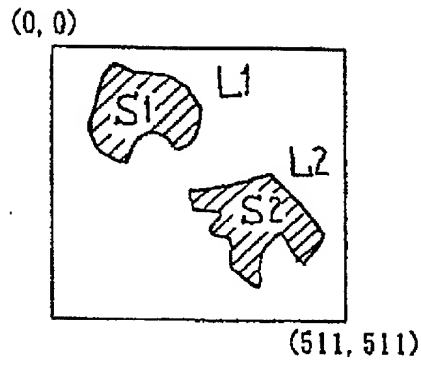


[FIG. 7]

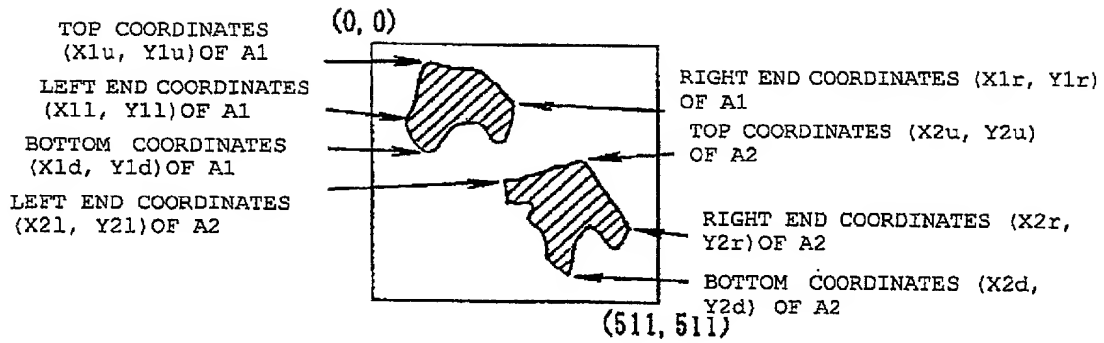




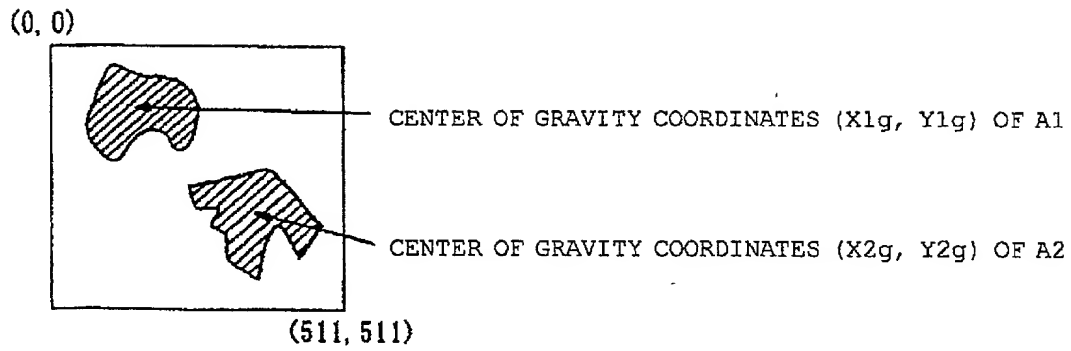
[FIG. 8]



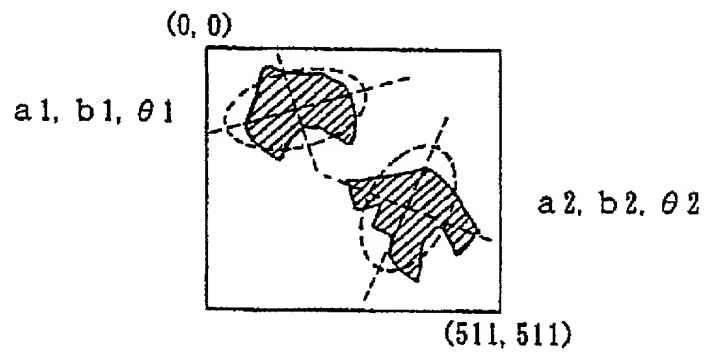
[FIG. 9]



[FIG. 10]



[FIG. 11]



Ref. \_\_\_\_\_

**COMBINED DECLARATION AND POWER OF ATTORNEY**

As a below named inventor, I hereby declare that

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

the specification of which: *(check one)*

**REGULAR OR DESIGN APPLICATION**

- ☐ is attached hereto.
- ☐ was filed on \_\_\_\_\_ as application Serial No. \_\_\_\_\_ and was amended on \_\_\_\_\_ (if applicable).

**PCT FILED APPLICATION ENTERING NATIONAL STAGE**

- ☒ was described and claimed in International application No. PCT/JP00/00949 filed on February 18, 2000 and as amended on \_\_\_\_\_ (if any).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, §1.56.

**PRIORITY CLAIM**

I hereby claim foreign priority benefits under 35 USC 119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed.

**PRIOR FOREIGN APPLICATION(S)**

Country	Application Number	Date of Filing (day, month, year)	Priority Claimed
Japan	11-42295	19/02/1999	Yes

*(Complete this part only if this is a continuing application.)*

I hereby claim the benefit under 35 USC 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of 35 USC 112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37 Code of Federal Regulations §1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application:

(Application Serial No.)

(Filing Date)

(Status--patented, pending, abandoned)



## POWER OF ATTORNEY

00466

PATENT TRADEMARK OFFICE

The undersigned hereby authorizes the U.S. attorney or agent named herein to accept and follow instructions from Universal Patent Bureau as to any action to be taken in the Patent and Trademark Office regarding this application without direct communication between the U.S. attorney or agent and the undersigned. In the event of a change in the persons from whom instructions may be taken, the U.S. attorney or agent named herein will be so notified by the undersigned.

As a named inventor, I hereby appoint the following attorney(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith: Robert J. PATCH, Reg. No. 17,355, Andrew J. PATCH, Reg. No. 32,925, Robert F. MARGEST, Reg. No. 25,590, Benoit CASTEL, Reg. No. 35,041, Eric JENSEN, Reg. No. 37,855, Thomas W. PERKINS, Reg. No. 33,027, and Roland E. LONG, Jr., Reg. No. 41,949, c/o YOUNG & THOMPSON, Second Floor, 745 South 23rd Street, Arlington, Virginia 22202.

Address all telephone calls to Young & Thompson at 703/521-2297.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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Inventor's signature \_\_\_\_\_ Date \_\_\_\_\_

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Citizenship:

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Full name of third joint inventor, if any:  
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Inventor's signature \_\_\_\_\_ Date \_\_\_\_\_

Residence:

Citizenship:

Post Office Address: